PENNSYLVANIA STATE LIBRARY
DOCUMENTS SECTION

INFORMATION CIRCULAR 5

PENNSYLVANIA GEOLOGICAL SURVEY
FOURTH SERIES

Relation of Stratigraphy and Structure To Uranium Occurrences Near Mauch Chunk, Pennsylvania

BY

JAMES L. DYSON

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF INTERNAL AFFAIRS
WILLIAM S. LIVENGOOD, JR., *Secretary*

TOPOGRAPHIC AND GEOLOGIC SURVEY
CARLYLE GRAY, *Acting Director*

1955

Digitized by the Internet Archive
in 2016 with funding from
This project is made possible by a grant from the Institute of Museum and Library Services as administered by the Pennsylvania Department of Education through the Office of Commonwealth Libraries

https://archive.org/details/relationofstrati00dyso

Relation of Stratigraphy and Structure To Uranium Occurrences Near Mauch Chunk, Pennsylvania

JAMES L. DYSON
Lafayette College

Reprinted from PROCEEDINGS OF THE PENNSYLVANIA ACADEMY OF SCIENCE,
pages 124-134. Vol. XXVIII, 1954

RELATION OF STRATIGRAPHY AND STRUCTURE TO URANIUM OCCURRENCES NEAR MAUCH CHUNK, PENNSYLVANIA[1]

James L. Dyson
Lafayette College

INTRODUCTION

Since 1951 two additional occurrences of significantly radioactive rocks have been discovered along the Lehigh River in the Mauch Chunk area, thus bringing the number of known occurrences there to three, and extending the area in which such radioactive zones are known a distance of five miles north of Mauch Chunk.

Although the geologic age of these deposits ranges from late Devonian to early Pennsylvanian (Pottsville) inclusive, they all lie along the southwest edge of the Pocono Plateau in the border zone between the gently folded or nearly horizontal rocks of the Plateau and the strongly folded region to the west. This is the only section of the Allegheny Plateau border which lies athwart the strong folds of the Folded Appalachian Province. In this zone beds traced along the strike may vary in attitude from near vertical to horizontal within a distance of several miles. Normal to the strike variations in dip are even more sharp, horizontal and vertical beds being essentially in juxtaposition at places. It may be that there is some relation between this border zone, where fracturing undoubtedly is more severe than in adjacent areas, and the concentration of uranium.

Although the course of the Lehigh River through this section is essentially normal to the regional strike, for much of its length the river actually flows at right angles to this direction and is definitely structurally controlled (Fig. 1). It is possible that those parts of the river's course which lie at right angles to the strike of the strata are also structurally controlled, since joints striking approximately parallel to the river appear to be more numerous at these places than elsewhere. In the area under consideration the courses of all tributary streams are parallel to the strike of the folds, in most cases being in prolongation of the strike-controlled sections of the river (Fig. 1).

---

[1] The part of this paper dealing with the Mt. Pisgah occurrence is published with the permission of the Lehigh Coal and Navigation Company.

URANIUM OCCURRENCES

Mt. Pisgah

This occurrence, known for many years (Wherry, 1914), extends from the eastern end of Mt. Pisgah at Mauch Chunk westward on the north side of the mountain along U. S. Highway 309 for a distance of approximately 2700 feet (Point A on Figs. 1 and 2). The enclos-

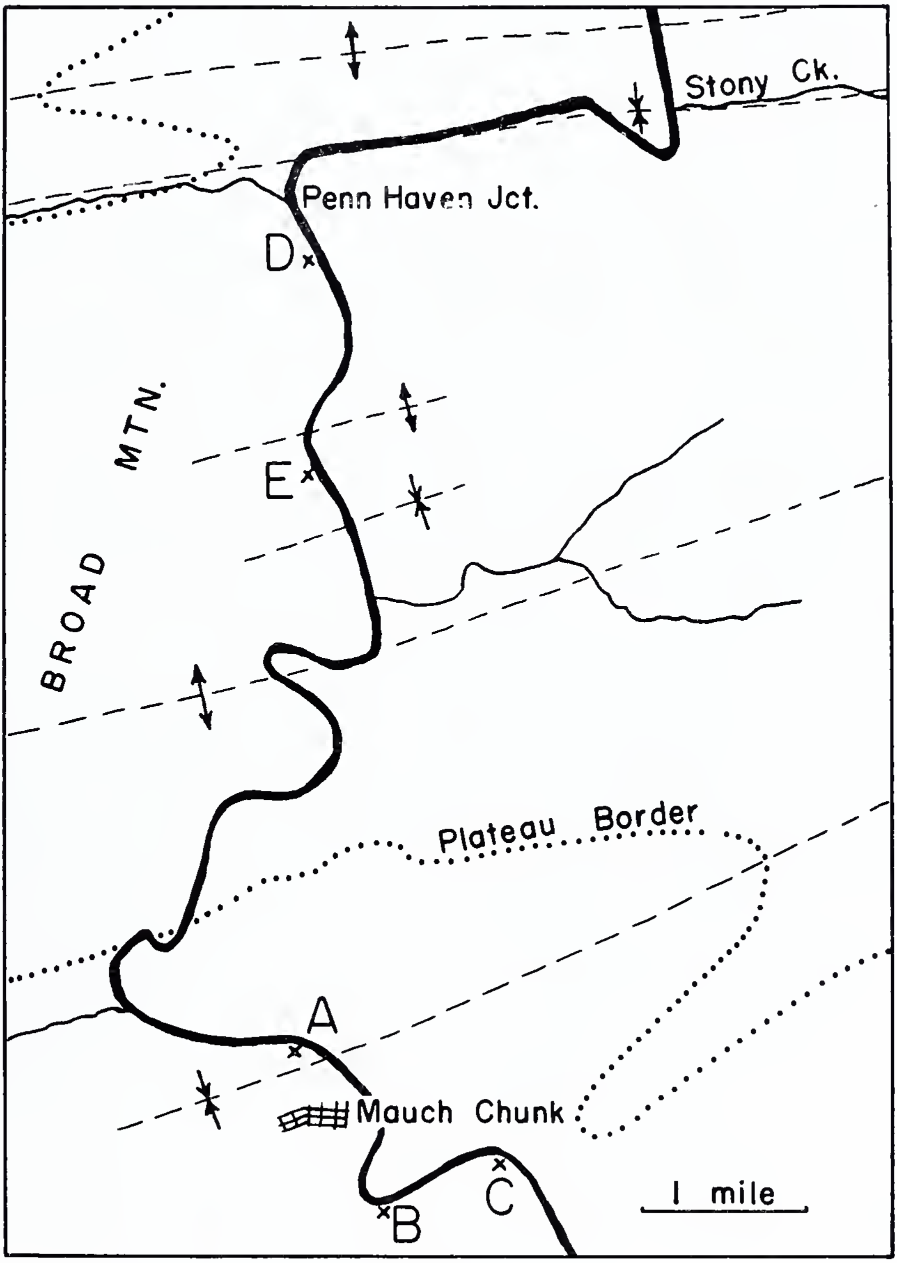

Fig. 1

ing rock which Wherry recognized as the basal part of the Pottsville formation is a 70-foot thick lens or channel-filling of conglomerate and sandstone. Until 1952 carnotite, the yellow color of which led to discovery of the deposit, was the only uranium mineral known at this location. Subsequently, as pointed out by Arthur Montgomery (1954) in a paper published in this volume of the Proceedings, a number of additional uranium minerals were discovered. The Lehigh Coal and Navigation Company, owners of the property on which the uranium occurs, have been interested in the possible exploitation of the deposit and have done a considerable amount of exploration work. Geologists of the Atomic Energy Commission and the U. S. Geological Survey have also been interested in the deposit and have been investigating it, as well as watching with interest the exploration activities.

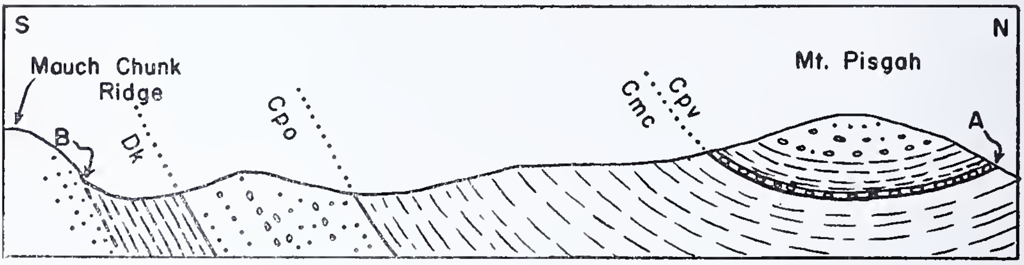

Fig. 2. Section through points A and B in Fig. 1. Lined strata are dominantly redbeds.

Structurally, the outcrop of radioactive rock lies on the north flank of a major west-plunging syncline (Fig. 2) locally known as the Panther Valley Coal Basin. On top of synclinal Mt. Pisgah about one mile west of the uranium occurrence is the extreme eastern end of the compound Southern Anthracite Coal Basin. Although at Mauch Chunk the syncline is simple and somewhat asymmetrical (steeper dip on south), it becomes compound toward the west, and within a distance of three or four miles is a distinct synclinorium.

Although dips of the uranium-bearing strata vary from nearly zero, near the synclinal axis, to about 50°, strata containing the greatest concentrations of radioactive material thus far found have dips varying from 26° to 46°. The fold axis strikes N 72°E, but the beds, because of the plunge, have a strike of approximately N 80°E to N 85°E at the uranium site. Shearing along bedding surfaces has been pronounced as indicated by the abundance of conspicuous slickensides. Locally these shears cut across the strata with the same strike but usually with a dip angle greater than that of the adjacent strata. Several conspicuous north-dipping shears (22° to 27°) with a strike of N 35°W to N 47°W are also present, and one south-dipping thrust fault with a displacement of several feet shows near the east end of the exposure.

The rock in which uranium occurs constitutes a distinct lithologic unit at the base of the Pottsville formation, consisting of dark gray arkosic sandstone and conglomerate with a dark gray matrix. This unit, which for the sake of convenience I shall refer to as the U-Member of the Pottsville, varies in thickness from 64 feet to 78 feet, the average being about 72 feet. The pebbles in the conglomerate are mainly white quartz but locally dark shale or slate fragments are conspicuous. Study of thin sections, as pointed out by Montgomery, reveals a number of other minerals and rock fragments. The largest quartz pebbles are one and one-half to two inches in diameter. The U-Member lies on top of grayish-red shales and siltstones of the Mauch Chunk formation. Similar redbeds are interbedded with non-red sandstones and conglomerates in the lower part of the Pottsville formation.

The U-Member consists of three distinct divisions, a top unit consisting of dark gray sandstone and siltstone which grades into the overlying red sediments, a middle unit consisting of conglomerate and coarse dark gray sandstone lenses, few of which extend laterally more than several yards, and a lower unit of dark gray sandstone and greenish-gray silstone. Average thicknesses of these units are: top, 21 feet; middle, 45 feet; and lower, six to seven feet.

Cross-bedding, present throughout the member, is most pronounced in the middle unit. Small lenses, normally not more than three to six inches thick, of carbonaceous sandstone with thin films of coal in their centers are common in the middle unit. High radioactivity is frequently associated with these lenses.

Above the U-Member the zone in which red and non-red strata interfinger is about 284 feet thick; if the U-Member is included in this transitional zone the stratigraphic thickness of the zone is about 360 feet. At Nesquehoning Gap, approximately three and one-half miles west of the Mt. Pisgah occurrence, the U-Member cannot be identified. A 50-foot unit of buff-weathering sandstone lies at the base of the transitional zone, which there too is 360 feet thick.

In the gap through Nesquehoning Mountain north of Tamaqua, approximately 12 miles west of Mauch Chunk, the zone of intertonguing red and non-red beds in the lower part of the Pottsville is fully 400 feet thick. Neither here nor at Nesquehoning do the basal Pottsville rocks exhibit radioactivity.

Carnotite, the most conspicuous uranium mineral present, occurs in both the conglomerate and the sandstone. In the conglomerate lenses it occurs in fractures, in spaces between pebbles, and in fractures within pebbles. In the sandstone it is limited to fractures, especially shears. It is associated with other uranium minerals such as tyuyamunite (Montgomery, 1954), and is present in appreciable concentrations to a depth of approximately 100 feet.

A black radioactive mineral discussed in detail by Arthur Montgomery (1954) is disseminated through the dark sandstones and sandy conglomerates. In the majority of cases, and always where the highest values of U_3O_8 are present, the rock bearing this mineral contains a high percentage of carbonaceous material; in some cases this consists of shale fragments, but more frequently finely disseminated material. In some of the drill cores obtained by the Lehigh Coal and Navigation Company it is possible to identify merely by inspection the zones containing the highest U_3O_8 values because of the presence of carbon. A typical high-value rock is a black sandstone, in part coaly material, containing white quartz pebbles up to one-half inch in diameter. Not infrequently this rock is cut by shears with slickensided surfaces on which secondary yellowish and greenish uranium minerals may be present. Radioactivity is very high at such enriched places. Noncarbonaceous rock cut by conspicuous shears normally exhibits no, or only negligible, radioactivity. Fractures filled with quartz, most of which are not parallel to the bedding, are rarely associated with pronounced radioactivity.

Examination of a number of cores taken from this occurrence by the Lehigh Coal and Navigation Company shows that 40 per cent of the shears encountered exhibited no radioactivity; the remaining 60 per cent were associated with radioactivity, in most cases high. Of this number half exhibited visible yellowish and greenish uranium minerals, and in practically all cases were also associated with carbonaceous material.

Examination of carbonaceous lenses, not associated with shears, revealed that 30 per cent exhibited no radioactivity; the remaining 70 per cent were radioactive, in most cases to a high degree. Thirty-five to 40 per cent of these contained secondary yellowish and greenish uranium minerals. One or two fossil logs exposed on the outcrop are associated with a high concentration of carnotite.

Since the concentration of uranium is definitely controlled by lenses with a high percentage of carbonaceous material and to a somewhat lesser extent by fractures, most of which are parallel to the strata, the most radioactive rock bodies are lenticular and their longest dimensions are parallel to the strata. A few cross-cutting shears intersect favorable rock masses of irregular shape and thus give rise to irregularly-shaped radioactive bodies. These are the exception rather than the rule.

Drilling operations have shown that lenses with pronounced radioactivity are confined almost entirely to the middle unit of the U-Member. The average thickness of the barren zone at the top of the member is 24 feet, that at the bottom 23 feet; thus the average thickness of the central part of the member in which radioactive lenses occur is 26 feet. Such lenses are relatively numerous and a considerable number of them have been discovered by core drilling. Their thicknesses, measured normal to bedding planes, vary from a few inches to approximately six feet. Dimensions parallel to the bedding have been more difficult to determine, but probably in few cases do they exceed 20 feet.

Radioactivity along the outcrop of the U-Member, as determined by radiation instruments, is pronounced. A Halross Scintillometer, Model 939, carried along the outcrop at a distance of three feet from the rock surface records several hundred counts per minute (above a background of 30 to 40 counts) over an aggregate distance of more than 500 feet, and in several places registers a far higher count. Chemical analyses of representative samples taken from several of the lenses, including the largest one, show average content of U_30_8 from 0.2 per cent to 0.5 per cent.

Mauch Chunk Ridge

A more recently discovered uranium occurrence is located just south of Mauch Chunk at the eastern end of Mauch Chunk Ridge in the gap cut by the Lehigh River between that ridge and Bear Mountain (Fig. 1, point B). This location was found in 1949 by geologists of the U. S. Geological Survey (McKeown, 1949) during the course of a radiometric survey along U. S. Highway 309. The length of the radioactive zone has not been determined but it definitely extends from a point on U. S. Route 309 about one-half mile south of the railway station in Mauch Chunk, to the Lehigh Valley Railway bridge over the Lehigh River about one mile east of Mauch Chunk. Although radioactivity is not continuous throughout this zone its length is nearly three-fourths of a mile. At the location along the highway the strata are medium olive-gray sandstones on the surfaces of which are scattered muscovite flakes. Beds strike N 60°E and dip northward toward the axis of the Panther Valley Syncline at an angle of 77° (Fig. 2, point B). Many bedding surfaces are conspicuously slickensided and a prominent set of joints with attitude N 42°W, 72°S is present.

These strata are a part of a thick series which was deposited in an alluvial environment in upper Devonian time, and belong to the Catskill continental facies. The uranium-bearing strata are situated at the bottom of a series of dominantly red (grayish-red) sandstones, pebbly sandstones, siltstones, and shales which lie between the Honesdale beds and the Pocono formation. This dominantly red series is approximately 750 feet thick (measured on a continuous exposure along Route 309 south of Mauch Chunk) and, based upon Willard's correlations (1936, p. 577), may constitute the whole of the Cherry Ridge group of beds. The uranium horizon here is stratigraphically about 4150 feet below the base of the Pottsville and 2000 feet below the Mauch Chunk shale.

The radioactive zone is six to 10 feet wide (measured across the strata) and can be traced vertically up the cliff face about 30 feet. The presence of poorly preserved plant fossils in the zone of greatest radioactivity and highest concentration of visible uranium minerals indicates a probable relationship. In a following paper Montgomery (1954) discusses the occurrence of meta-autunite and other uranium minerals from this site.

The only other site in this zone where visible uranium minerals occur is three-fourths of a mile to the east along the Central Railroad of New Jersey (Fig. 1, point C). In a gray sandstone containing olive-gray mud pellets and several thin clay seams carnotite and other uranium minerals occur as conspicuous yellow and apple-green coatings on bedding and closely spaced fracture surfaces. This zone is approximately three feet wide and the entire radioactive zone nearly 20 feet wide (measured stratigraphically). The minerals in this zone have not yet been studied in detail. This site and the meta-autunite zone three-fourths of a mile to the west are at exactly the same stratigraphic horizon. At three intermediate locations along the railroad between these two sites the scintillometer registers significantly high counts although no uranium minerals are visible at the outcrops.

Penn Haven Junction

Five miles north of Mauch Chunk on the west bank of the Lehigh River about 600 yards south of Penn Haven Junction (Mauch Chunk Quadrangle, 1:62,500) Harry Klemic of the U. S. Geological Survey discovered a radioactive outcrop[1] in August 1953 (Fig. 1, point D).

---

[1] Oral communication.

It is located at the crest of a minor anticline in dark gray sandstone containing flattened mud pellets and appears to be lithologically similar to the rock at the meta-autunite occurrence south of Mauch Chunk. Radioactivity is confined to a zone one to four feet thick which is parallel to the strata and is exposed for a distance of about 200 feet in the cliff along the Lehigh Valley Railroad tracks. At one spot where flaky greenish-yellow minerals are associated with a sulphide which appears to have replaced plant fragments the scintillometer registers 2500 counts per second, a reading approximately equal to the highest count registered at the Mt. Pisgah location at the outcrop of a large lens with average U_3O_8 content of 0.5 per cent. The uranium-bearing strata apparently are present on the east bank of the river since some radioactivity, despite a cover of rubble, has been detected there.

The site is on the north flank of the Broad Mountain Anticline (Fig. 1), a major structure on which the Pocono Plateau is carried westward about 14 miles beyond the Lehigh River. Along the river several minor folds are superimposed upon this major structure. The course of Stony Creek and the nearly east-west segment of the river's course east of Penn Haven Junction follow the axis of a major syncline (Fig. 1). At Penn Haven Junction a nearly vertical fault with upthrow side on the north marks this synclinal axis. Displacement has not been determined but is probably not greater than 100 feet. At the fault nearly vertical beds of Pocono sandstone are in contact with nearly horizontal beds of Mauch Chunk shale. The strike of the synclinal axis and the fault is N 82°E.

The uranium zone lies stratigraphically about 1550 feet below the Mauch Chunk shale, an interval 450 feet less than that between the Catskill uranium and the Mauch Chunk shale at Mauch Chunk.

Above the uranium zone are 685 feet of interbedded sandstones, siltstones, and shales of which 287 feet are redbeds. Between this series and the Mauch Chunk shale are 850 feet of non-red sandstones and conglomerates definitely belonging to the Pocono. If the base of the Pocono is placed at the bottom of the non-red beds, where there is a sharp break, the formation is about 500 feet thinner than it is at Mauch Chunk. Putting the base farther down to include a number of redbeds would present a problem in view of the fact that placing the base of the Pocono at the top of the zone in which redbeds are predominant would assign a thickness to the formation in excess of 1600 feet. This seems all the more undesirable since the Pocono thins northward from Mauch Chunk. It is not my intention, however, to consider further this problem of the Pocono base because a number of others (Wilmarth, 1938, pp. 1687-1689) have already done so, and further, I have made no detailed study of the problem.

It is evident, though, that the transition zones between Catskill and Pocono at Mauch Chunk and Penn Haven Junction are quite different. There is a much greater aggregate thickness of redbeds at the former location, and the grayish-red pebbly sandstones, probably Willard's Pimple Hill conglomerate (1936, p. 578), so prominent in Mauch Chunk Ridge (and its counterpart Bear Mountain east of the river), are absent at Penn Haven. The greater thickness of strata at Mauch Chunk may be due in part to faulting.

It would appear that the uranium zone at Penn Haven is below the Pocono, probably not far stratigraphically from the Mauch Chunk Ridge occurrence.

One other radioactive outcrop, at approximately the same stratigraphic horizon as the Penn Haven occurence, is located on the west side of the river along the Lehigh Valley Railroad tracks 1.66 miles south of Penn Haven Junction (Fig. 1. point E). There an olive-gray shale and arkosic sandstone exhibit radioactivity along two fractures with an attitude of approximately N 70°E, 40°N. On the outcrop the mineralized zone has an area of not more than several square feet. The strata strike N 82°E and dip 15° south, and the site is close to the axial plane of the Broad Mountain Anticline.

SUMMARY AND CONCLUSIONS

At all three uranium localities in the Mauch Chunk area there has been definite sedimentary control of the mineralization. Despite the presence of numerous joints striking across the strata uranium mineralization is confined in all cases within very narrow stratigraphic limits. At Mt. Pisgah radioactivity, although traced along the strike for more than 2500 feet, is limited to the central part of the U-Member. Within this zone individual radioactive bodies are confined generally to small sedimentary lenses with a high content of carbonaceous material. At the Mauch Chunk Ridge occurrence radioactivity is confined over a strike distance of three-fourths mile to a single narrow stratigraphic horizon. At Penn Haven sedimentary control is also evident. As a matter of fact the apparent stratigraphic coincidence of the two occurrences south of Penn Haven and the one south of Mauch Chunk is in itself indicative of an even broader sedimentary or stratigraphic control. Further, the alignment in a nearly north-south direction of the three Catskill occurrences is an indication that the uranium may have been deposited by a stream, or streams, coming from the Precambrian crystalline areas to the south and southeast, especially since the few good exposures of ripple marks in the Catskill and Pocono sediments indicate currents from those directions. Conceivably the uranium now found in rocks of Pottsville age could have been deposited when streams were eroding a similarly situated crystalline mass with a relatively high uranium content.

Undoubtedly structural control, especially at Mt. Pisgah, was exercised by shears, most of which are parallel to the strata. A major structural feature which may have furnished considerable control over the whole area is the plateau border zone where severe stretching of the strata undoubtedly resulted in increased fracturing. The fault at Penn Haven and several relatively small strike and cross faults noted in the area probably are expressions of forces more or less peculiar to this border zone.

There is a possibility that uranium was introduced in the form of the primary oxide uraninite or a uraninite-like mineral, by hydrothermal solutions. Favoring this theory is the presence, in the Mt. Pisgah deposit, of such a mineral (Montgomery, 1954). Furthermore, the alignment in a north-south direction of all four occurrences (three in Catskill and one in Pottsville) within the fold-plateau border zone is a strong indication that major control may have been structural. Although the individual Catskill and Pottsville deposits have been subjected to sedimentary control, the great stratigraphic distance between the deposits in rocks of these two ages is indicative also of some type of structural control.

On the other hand if the uranium were hydrothermally introduced in post-Pottsville time, assuming such uranium has some affinity for carbon, it is difficult to understand why uranium is not present higher in the Pottsville where there is much of this material. If the present major fold structures existed when the original mineralization took place ascending solutions would not have had to rise as far to the base of the Pottsville and the Coal Measures in the Panther Valley syncline as at the nearby Mt. Pisgah occurrence. Further, it would seem that if hydrothermal solutions brought the uranium it would be present at a number of stratigraphic horizons inasmuch as rocks essentially identical to those in which the uranium occurs are distributed vertically throughout much of the Pocono, Pottsville, and higher parts of the Catskill. And in many cases these barren rocks are just as much fractured.

In any event to account for the origin of uranium in the Mauch

Chunk area the following factors, and perhaps others, must be given consideration: (1) the sedimentary control, (2) presence of carbon in the sediments, (3) shears and other minor fractures, (4) alignment of deposits in a nearly north-south line in the fold-plateau border zone, (5) great stratigraphic distance between the Catskill and Pottsville deposits, and (6) the probable hydrothermal mineral in the Mt. Pisgah deposit.

LITERATURE CITED

McKeown, F. A. 1949. Preliminary report of uranium deposits near Mauch Chunk, Pa. U. S. Geol. Survey Trace Elements Mem. Rept. 19. (Unpublished.)

Montgomery, Arthur. 1954. Uranium minerals of the Mauch Chunk area, Pennsylvania. Pa. Acad. Sci., Proc. 28.

Wherry, Edgar T. 1914. Carnotite near Mauch Chunk, Pennsylvania. U. S. Geol. Survey, Bull. 580:147-151.

Willard, Bradford. 1936. Continental Upper Devonian of northeastern Pennsylvania. Geol. Soc. Amer., Bull. 47:565-608.

Wilmarth, M. Grace. 1938. Lexicon of geologic names of the United States. U. S. Geol. Survey, Bull. 896.